Abundance, Age, Size, Sex and Coded-Wire Tag Recoveries for Chinook Salmon Escapements of Campbell and Quinsam Rivers, 1998

J. C. Sturhahn, D. A. Nagtegaal, and M. Trenholme

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
Nanaimo, British Columbia
V9R 5K6

2000

Canadian Manuscript Report of Fisheries and Aquatic Sciences 2519

Fisheries and Oceans Canada
Science

Pêches et Océans Canada
Sciences

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Manuscript reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 1426 - 1550 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Manuscript Reports. The current series name was changed with report number 1551.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques ques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports manuscrits sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annual des publications scientifiques et techniques du Ministère.

Les numéros 1 à 900 de cette série ont été publiés à titre de manuscrits (série biologique) de l'Office de biologie du Canada, et après le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada. Les numéros 901 à 1425 ont été publiés à titre de rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Les rapports manuscrits sont produits a l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Manuscript Report of

Fisheries and Aquatic Sciences 2519

2000

ABUNDANCE, AGE, SIZE, SEX AND CODED-WIRE TAG RECOVERIES FOR CHINOOK SALMON ESCAPEMENTS OF CAMPBELL AND QUINSAM RIVERS, 1998

by

J. C. Sturhahn, D. A. Nagtegaal, and M. Trenholme[1]

Fisheries and Oceans Canada

Science Branch, Pacific Region

Pacific Biological Station

Nanaimo, British Columbia

V9R 5K6

[1]Quinsam River Hatchery, 4217 Argonaut Road, Campbell River, BC V9W 7P6

Cat. No. Fs 97-4/2519E ISSN 0706-6473

Correct citation for this publication:

Sturhahn, J. C., D. A. Nagtegaal, and M. Trenholme. 2000. Abundance, age, sex and coded-wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2519: 49 p.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Sturhahn, J. C., D. A. Nagtegaal, and M. Trenholme. 2000. Abundance, age, sex and coded-wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2519: 49 p.

Chinook salmon (*Oncorhynchus tshawytscha*) escapement estimates were derived for the Campbell/Quinsam River system for 1998 utilising carcass tag and recovery methods as part of the chinook key stream program. The Petersen estimate of chinook escapement was 4,704 with 95 % confidence limits of 4,441 to 4,967 fish (not including jacks and jimmies). This estimate includes hatchery removals (sales, broodstock, mortalities) and chinook which were permitted to move above the hatchery fence. Three-year old males (0.2; 0 freshwater, 2 ocean) and four-year old (0.3; 0 freshwater, 3 ocean) females dominated returns to the Quinsam River while four-year old (0.3) males and females predominated returns to the Campbell River. Total returns of coded-wire tagged chinook to the Campbell/Quinsam system were 351 in 1998. For the purposes of this study, escapement estimates are stratified by river, sex, and tag code. The hatchery contribution to the escapement was derived by expanding the actual number of coded-wire tag returns for each of the brood years and for each tag code. In 1998, the total hatchery contribution to the Campbell/Quinsam system was estimated to be 2,256 (88.6%) for males and 1,128 (55.8%) for females.

Key words: Campbell, Quinsam, chinook, key stream, escapement, coded-wire tags, live tagging, carcass tagging.

RÉSUMÉ

Sturhahn, J. C., D. A. Nagtegaal, and M. Trenholme. 2000. Abundance, age, sex and coded-wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2519: 49 p.

Pour 1998, des estimations concernant l'échappée des saumons quinnats (*Oncorhynchus tshawytscha*) ont été calculées pour le système des rivières Campbell et Quinsam et la saison 1998 au moyen de micromarques relevées sur des carcasses et de diverses méthodes de récupération dans le cadre du programme portant sur quelques cours d'eau représentatifs des remontes de saumons quinnats. L'échappée des saumons quinnats a été estimée à 4 704 individus par la méthode de l'estimateur multiple de Petersen, avec des limites de confiance (95 %) situées entre 4 441 et 4 967 individus (sans compter les jeunes saumons précoces d'un ou deux ans). Cette estimation inclut les ponctions des salmonicultures (ventes, géniteurs, mortalité) et les saumons quinnats qu'on a laissé passer au-dessus de la grille. Les mâles de trois ans (0.2; 0 en eau douce, 2 en mer) et les femelles de quatre ans (0.3; 0 en eau douce, 3 en mer) ont dominé la remonte dans la rivière Quinsam tandis que les mâles et les femelles de quatre ans (0.3) représentaient le gros de la remonte dans la rivière Campbell. L'effectif total des saumons quinnats de remonte porteurs d'une micromarque dans le système des rivières Campbell et Quinsam s'est élevé à 351 individus en 1998. Dans le cadre de la présente étude, les estimations de l'échappée sont classées par rivière, sexe et code de micromarque. La contribution de la salmoniculture à l'échappée a été calculée en extrapolant le nombre des spécimens de la remonte portant une micromarque pour chacune des années d'éclosion et pour chacun des codes de micromarque. En 1998, la contribution totale du système des rivières Campbell et Quinsam a été estimée à 2 256 (88,6 %) mâles et à 1 128 (55,8 %) femelles.

Mots clés: Campbell, Quinsam, quinnat, cours d'eau représentatifs, échappée, micromarques, relevé de micromarques sur des poissons vivants, relevé de micromarques sur des carcasses.

INTRODUCTION

One of the primary goals of Fisheries and Oceans Canada (DFO) long-term management plans is the restoration of Pacific chinook salmon stocks to historical levels. The Campbell and Quinsam River systems were chosen for study as important "key streams" which represent the overall status of chinook bearing streams along the British Columbia coast. These selected streams provide ongoing information to fisheries managers in response to artificial (hatchery), and natural production, and harvest management strategies. This "key stream" program began in 1984, in accordance with objectives set out in the Canada-U.S. Salmon Treaty.

The major objectives of the key stream program are:

1. to accurately estimate chinook escapement on key streams.

2. to estimate harvest rates and contributions to fisheries and escapement based on coded-wire tagged returns, including estimates of the total escapement of coded-wire tags to the key streams system; and

3. to estimate the contribution of hatchery and natural production to the escapement.

Chinook escapements to the Campbell River have ranged from 750 to 8,000 since 1947 (Shardlow et al. 1986). The Quinsam Hatchery, built in 1972 (first releases were from the 1974 brood year) approximately 3.7 kilometres up from the confluence with the Campbell River, enhances salmon and anadromous trout of the Quinsam and neighbouring streams. Chinook escapements to the Quinsam River were negligible prior to establishment of the Quinsam Hatchery, but increased to 1,500 and 1,800 in 1985 and 1986, respectively. The returns further increased to 5,300 in 1988 and 5,412 in 1990. Total system escapement peaked in 1990 with an estimated 15,538-returning chinook (Frith et al. 1993). The following year it dropped to 3,200 and by 1994 escapement had dropped to 2,982 (Frith and Nelson 1995).

The objective of this document is to provide a chinook salmon escapement estimate to the Campbell/Quinsam River system based upon carcass tag recovery using the Petersen method as well as returns of coded-wire tagged (CWT) adults. The escapement of coded-wire tagged adults is also used to estimate the Quinsam Hatchery contribution.

In the 1994 manuscript, Frith and Nelson discuss possible biases in the Petersen method, carcass tagging methodology, and stratification method. Frith and Nelson (1995) describe the assumptions necessary for the methods and tests for biases caused by violations of these assumptions. This information has been repeated for the readers' benefit. The methods section describes the snorkel surveys, the tag and recovery effort, biological and physical sampling, and calculations. The results section presents the swim survey observations, tag and recovery results, population estimates, age, length, and sex composition, and the results of the coded-wire tag returns.

For the purposes of this report, 'tagging' means to attach a staple tag to the operculum of a deceased, spawned out chinook salmon. 'Marked' fish refer to those returning adults lacking an adipose fin and presumably carrying a coded-wire tag applied during their juvenile stage prior to release from the hatchery.

STUDY AREA

The physical attributes of the Quinsam/Campbell drainage area have been described in detail by Andrew et al. (1988). The Campbell River originates east of the Vancouver Island Ranges and drains some 1,465 km^2 of land (Figure 1). The river flows in an easterly direction for approximately 9km where it empties into Discovery Passage at a point slightly north of the City of Campbell River, British Columbia. One of the major tributaries of Campbell River is the Quinsam River, which drains a watershed of 265 km^2 and enters the Campbell River 3.5km from the estuary. The Quinsam River flows for over 30 km through a series of small lakes and is fed by numerous tributaries to the south of the Campbell River watershed including Cold Creek, Flintoff Creek, and the Iron River (Andrew et al. 1988).

Water flow on the Quinsam River has been regulated since 1956 by an hydroelectric dam situated above Middle Quinsam Lake approx. 5.5 km upstream of the mouth. This dam allows flow control and enables maintenance of minimum flow rates during dry periods. Flow rates have ranged from 0.9 to 21.6 m^3s^{-1} with a mean of 9.2 m^3s^{-1} (Bell and Thompson, 1977), since 1973. Flows in the Campbell River are controlled by the John Hart Generating Station and vary from 1.2 m^3s^{-1} to 826.0 m^3s^{-1} with a mean of 96.0 m^3s^{-1} (Marshall et al. 1977).

The upper watersheds of the Campbell and Quinsam Rivers are impacted by the logging and mining industries while logging roads provide access for extensive recreational use. Commercial activity in the Campbell River estuary includes log booming, sawmill operations, shake mills, floatplane facilities, and recreational boat moorages (Andrew et al. 1988). Man-made islands have been constructed in the estuary in an effort to improve fish habitat (Levings et al. 1986).

Numerous species of Pacific salmon are found in the Campbell/Quinsam system including pink (*Oncoryhnchus gorbuscha*), chinook (*O. tshawytscha*), chum (*O. keta*), coho (*O. kisutch*), and sockeye (*O. nerka*) in order of abundance. Steelhead trout (*O. mykiss*) and Cutthroat trout (*O. clarki*) are also found in this system.

Although 27 km of the Quinsam River are accessible to natural spawning, the majority of chinook spawning occurs in the lower 4 km of the river. A portion of chinook is permitted to pass through the counting fence at the Quinsam Hatchery and to spawn in the upper reaches of the lower Quinsam River. Mature chinook begin returning to the Campbell River in late August with the migration peaking in October. Spawning occurs over several weeks from mid October to mid November. Quinsam River chinook enter the system in early October, peak in late October, and finish by late November. Coho have recently been seen spawning in the Second Island Channel on

the Campbell. Chum and pink salmon spawn in the lower reaches of both the Campbell and Quinsam Rivers.

METHODS

POPULATION ESTIMATION

The 1998 chinook salmon escapement estimates were determined using the adjusted Petersen method (Ricker 1975). Escapement estimates were calculated for each river and sex using carcass tagging and recovery techniques. These estimates were then combined with the Quinsam Hatchery returns plus those adults counted above the hatchery fence to produce an estimate of escapement for the entire Campbell and Quinsam River system.

Population Stratification

Carcass Tagging: Petersen estimates were stratified by sex and river and then summed to obtain an estimate of the whole population. By segregating the data into separate population strata, potential biases due to differential rates of tag application, recovery of carcasses, and tag loss were minimised (Andrew et al. 1988). Petersen estimates were generated for the Campbell River and the Quinsam River (below the fence).

Potential Biases

Carcass Tagging: Within a stratum, Petersen estimates using carcass tagging are subject to bias depending on the extent to which these assumptions are violated (Andrew et al. 1988; Bocking et al. 1990).

Tests used to evaluate bias of the Petersen estimate in this study are also presented and discussed below. Certain biases caused by methods of tagging, recovery, and age determination are discussed in subsequent sections.

Assumption 1. Tags are applied in proportion to the available population, the distribution of recovery effort is proportional to the number of fish present in each river reach, and tagged fish mix randomly with untagged fish.

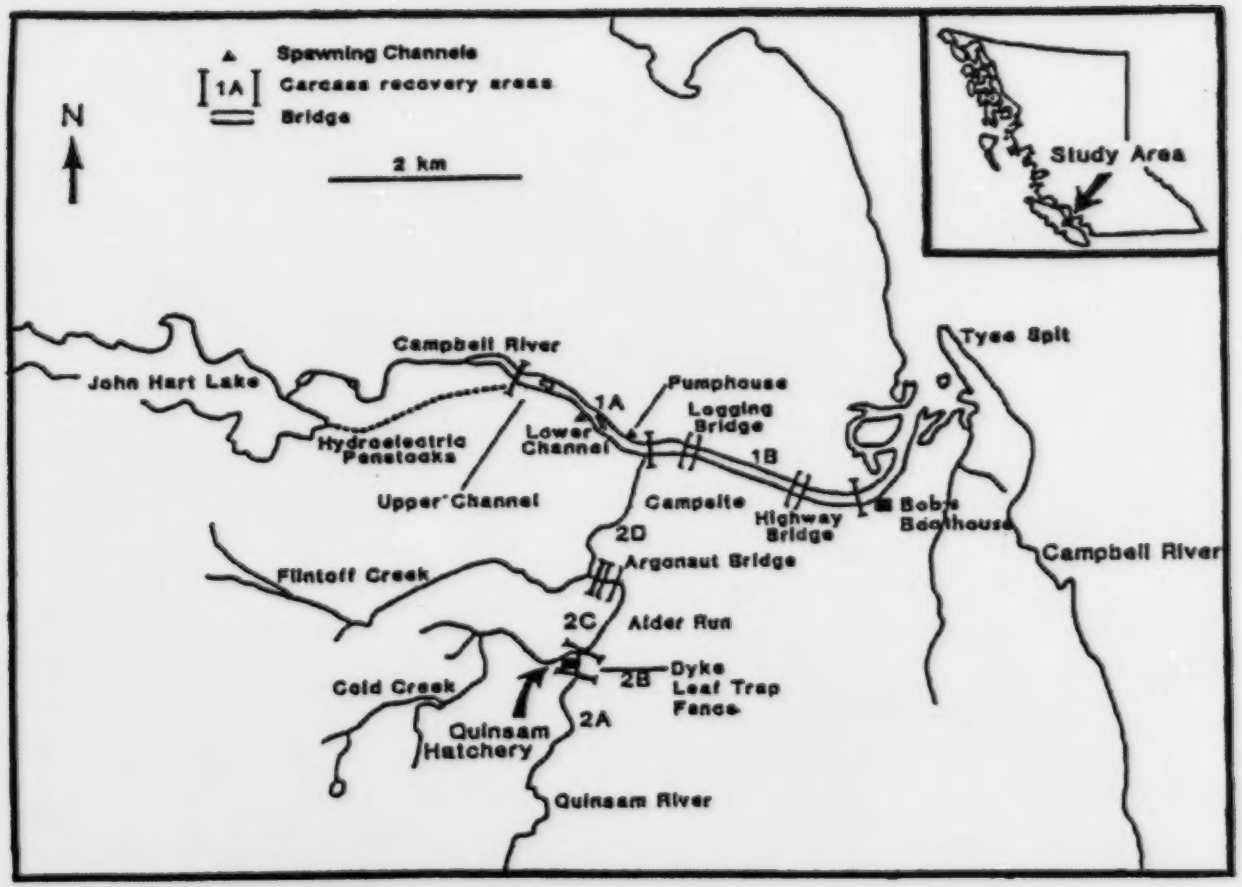

Figure 1. Map of the Campbell and Quinsam rivers study area.

To obtain an accurate Petersen estimate, tags must be applied and recovered in proportion to the available population. In 1998, carcasses were tagged *in situ* during examination. Hatchery workers attempted to tag a consistent proportion of the number of fish examined during each recovery survey by tagging four of every ten carcasses in 1998. A higher tag rate was applied when the number of carcasses examined in a day was low. The percentage of fish tagged ranged from about 33-100% over the study period (Appendices 5 and 6).

A related problem associated with escapement estimates for separate rivers is that tagged carcasses may stray (washout) between rivers. Apart from passive movement due to water flow, tagged carcasses are not subject to movement or straying in the same way as live fish. In 1998, 2 strays were reported in the Quinsam or Campbell rivers.

Assumption 2. There are no (minimal) additional die-offs of spawners after the conclusion of tagging.

An addition of new carcasses following tagging could cause the Petersen calculations to overestimate or underestimate the true population depending on how they mixed with tagged fish. In 1998, tagging continued *in situ* in the rivers every 1 to 6 days during the spawning and die-off period. Tagging and recovery continued through to November 30.

Assumption 3. There is no tag loss.

A high incidence of tag loss will cause Petersen calculations to overestimate the true population. Tag loss was determined by a hole punch in the operculum of all tagged carcasses. A single hole punch was used to represent carcasses tagged in the Quinsam River while two holes represented carcasses tagged in the Campbell River. All secondary marks (opercular punches) were included in the tag recovery data and Petersen estimates.

Assumption 4. All tags are recognised and reported during recovery after the conclusion of tagging.

In this study, no duplicate pitches were conducted to re-examine carcasses for missed tags and secondary marks. Therefore, it was not possible to evaluate the validity of this assumption.

Assumption 5. Recovery efforts are made on the same population that was tagged.

Dead recovery from a population other than the tagged population will cause Petersen calculations to overestimate the true population. Indicators that tagging and recovery were conducted on different populations include different age frequency and length frequency distributions among the two samples. Since tagging occurred concurrently with recovery, this is an unlikely source of error.

Assumption 6. There is adequate sampling to provide an accurate and precise population estimate.

A small number of tag recoveries in a stratum will cause Petersen estimates to have low precision. Petersen estimates are generally more reliable if a high proportion of tagged fish are recovered in each stratum. In the absence of other sources of bias, the number of recoveries required to achieve a 25% accuracy with 95% confidence for populations (10^2 to 10^9) ranges from 25 to 75 (Ricker 1975).

Assumption 7. Tagged carcasses are representative of the population and behave in a similar manner to untagged carcasses with respect to buoyancy, visibility, and decomposition.

Tagged carcass recoveries will not be representative of the population if tagged carcasses do not mix completely with untagged carcasses (see Assumption 1), in which case the Petersen method may overestimate or underestimate the population. The thoroughness of mixing depends on whether tagged carcasses behave in a similar manner to untagged carcasses. The assumption of mixing cannot be tested with the data available from this study.

Buoyancy and decomposition may be important factors causing differential behaviour of tagged and untagged carcasses especially if tagged carcasses become bloated with air during handling. Differences in tag visibility could cause preferential sampling of tagged carcasses, and result in an underestimate of the population. An attempt was made to circumvent this problem using neutral colours to prevent increased visibility of tagged carcasses. It is not possible to test the assumption of similar visibility between tagged and untagged carcasses with the data from this study. The assumption of similar buoyancy and decomposition of tagged and untagged carcasses could be tested by comparing the tag recovery rate during dead recovery with the recovery rate at carcass weirs if such data were available.

Calculations

The adjusted Petersen estimate of each river stratum and sex was calculated as follows (Chapman's formula; Ricker 1975):

$$P_{i,r} = \frac{(C_{i,r}+1)(M_{i,r}+1)}{(R_{i,r}+1)} \qquad (1)$$

where P is the population estimate, C is the total number of fish recovered, M is the total number of fish tagged, and R is the number of tagged fish recovered and includes fish with missing tags (secondary marks only). The subscript i is the sex stratum and the subscript r is the river stratum.

Population estimates for sex and river (carcass tagging only) strata were summed to obtain a total in-river population estimate:

$$P_t = \sum_{i=1}^{n} \sum_{r=1}^{m} P_{i,r}$$

where n is the total number of sex strata and m is the total number of river strata.

Confidence limits for each stratum population estimate were obtained using fiducial limits for the Poisson distribution as described by Ricker (1975). The 95% confidence limits for the total escapement were then determined by assigning equal weights to all strata and summing the lower and upper confidence limits across strata.

Population estimates were not calculated for jack or stray chinook.

TAGGING

Tagging was conducted in tandem with the dead recovery effort. This enabled the tagging effort to be spread evenly throughout the recovery period (Appendices 1 and 2).

RECOVERY

Sampling crews that conducted the dead recovery were composed of two to six workers each day. Recovery crews were instructed to dead pitch and count all available carcasses and record and keep all operculum tags. Crews attempted to distribute recovery effort evenly throughout the study period. Dead chinook were surveyed for recoveries from the Campbell and Quinsam rivers by three methods:

1. Recovery crews searched the banks and shallow reaches of the rivers on foot and from a boat;

2. A SCUBA diver searched for carcasses in deep pools of lower reaches of the Campbell and Quinsam Rivers;

3. A recovery crew snorkel surveyed one of the new spawning channels (Second Island) in the Campbell River.

Chinook were also recovered at the Quinsam Hatchery rack and from a floating fence operated in area 2D of the Quinsam River (Figure 1). The floating fence used for adult capture was installed at the beginning of Oct. and was removed on Oct 22, 1998. This fence caught most carcasses, which drifted downstream in the current. Carcasses that were found on the fence were placed back onto the fence after being staple tagged and sampled. Chinook were collected in the

river although in high water conditions the majority of carcass tagging and recovery occurred on the banks of the rivers.

Each carcass was examined for the presence of an opercular tag and opercular punch hole(s), and the absence of an adipose fin. Heads were removed from adipose-clipped fish for sampling of CWT's. Data collected from carcasses are described in the biological and physical sampling methods section. All carcasses tagged during the recovery effort were released at the same location as they were tagged. All recaptured-tagged carcasses were cut in half to prevent recounting in subsequent dead pitches.

For Petersen mark-recapture estimates, only carcasses recovered after the first day of tagging were included in the values of C and R. It was assumed that 24 hours were required between tagging and recapture for sufficient mixing between tagged and untagged carcasses.

Other calculations relating to the dead recovery were as follows:

$$tag\ rate = R / C \tag{3}$$

where *tag rate* is an estimate of the proportion of the population that was tagged.

$$tag\ recovery\ rate = R / M \tag{4}$$

where *tag recovery rate* is an estimate of the proportion of tagged fish that were later recaptured.

BIOLOGICAL AND PHYSICAL SAMPLING

Biological sampling was conducted during the tagging procedure. Data collected include sex, presence of secondary marks, and postorbital-hypural lengths. Length was recorded for 90% of the carcasses (marked and unmarked fish) recovered in the Campbell River, 37% of the carcasses recovered in the Quinsam River, and 39% of the chinook recovered alive at the hatchery rack.

Scale samples were taken in conjunction with length measurements. In addition, a portion of adipose-clipped fish was sampled for age (CWT decoding) and length. A scraping of scales was placed in a labelled plastic envelope and the individual scales from each fish were mounted in scale books at the hatchery. Ageing of scales was conducted at the DFO scale laboratory at the Pacific Biological Station in Nanaimo. Heads were removed from adipose-clipped fish and saved for CWT extraction and decoding at the coded-wire tag dissection laboratory in Nanaimo.

Ageing data were accepted on the premise that the scales contained a portion of the previous annulus and were not regenerated. Scales were rejected at the ageing lab if they were mounted upside down, if they were resorbed, or if they had regenerate centres. Ages were recorded for fish where at least two scales could be read for both marine and freshwater ages. The ageing system in this report follows the method originally described by Gilbert and Rich (1927). For the purposes of this report only the total age was reported.

The age composition determined with the available samples is valid only if age sampling was random and there was no bias in readability of scales with age. Ages of older fish are usually more difficult to read than those of young fish because scales of older fish usually undergo more resorption and regeneration. The data were examined for this potential bias using a t-test to compare mean lengths of known and unknown age males and females. The dead recovery sample was used to determine the age and length composition of the population. Because of problems in distinguishing jacks from adult males, age and length information for jacks was grouped with males.

The population of each age class was then determined by allocating portions of the Petersen estimate to age classes according to the age composition determined from scale samples and CWT decoding. The number of jacks was too small to estimate population size with accuracy and therefore escapement by age was determined for adult males and females only.

A sex ratio was determined from Petersen estimates for each river. The test for potential differences in tag loss is described in the tagging methods section. Tag recognition is not likely to be biased by sex, although it was not possible to test this potential bias with the data in this study.

CODED-WIRE TAGGING AND RECOVERY

Juvenile chinook from the 1991-1996 brood years were marked at Quinsam Hatchery with binary CWT's described by Jefferts et al. (1963) using standard methods (Armstrong and Argue 1977). Adipose fins of coded-wire tagged juveniles were clipped prior to the release of these fish.

Estimates of the contribution of hatchery-reared chinook to the total escapement were calculated by expanding the percentage of CWT tags in escapement counts by tag code. The number of successfully decoded CWT chinook in the escapement was estimated and stratified by river and sex using the methods described for the Mark Recovery Program (Kuhn 1988). This method is currently used by DFO to estimate hatchery contributions in commercial and sport chinook catches.

Estimating the total number of CWT returns from each of the brood years, and for each tag code, was done as follows.

First, the observed number of CWT recoveries was adjusted to account for "no pin" (no tag) recoveries:

$$ADJ_{i,r,tc} = OBS_{i,r,tc} \bullet \left[1 + \frac{LP}{K} + \frac{ND \bullet (K + LP)}{K \bullet (K + LP + NP)}\right] \quad (9)$$

where *ADJ* is the adjusted number of observed CWT fish, *OBS* is the observed number of CWT fish, K is the sum of all successfully decoded tags for all tag codes recovered, *LP* is the number of lost pin recoveries, *ND* is the number of no data recoveries, *NP* is the number of no pin recoveries, and i, r, and *tc* are the subscripts denoting sex, river, and tag code, respectively.

This adjusted number of CWT recoveries was then used to estimate the total number of CWT returns for each tag code:

$$EST_{i,r,tc} = \frac{ADJ_{i,r,tc} \bullet P_{i,r}}{C_{i,r}} \quad (10)$$

where EST is the estimated number of CWT recoveries for a single tag code, C is the number of fish examined, P is the population estimate, and i, r, and tc are subscripts denoting sex, river, and tag code.

This approach of estimating the number of CWT chinook in the escapement assumes that any adipose-clipped chinook found without CWT's were never marked. This assumption is only valid if chinook tagged with a particular tag code did not lose the CWT after release from the hatchery (i.e. after accounting for tag loss during a retention test). Since 90% of tag loss occurs within four weeks of tagging (Blankenship 1990), any fish released within this four-week period are more susceptible to tag loss prior to being recovered in the fishery or escapement. Violation of the assumption of no tag loss will result in a negative bias in the hatchery contribution estimates. Other potential sources of bias using this method are discussed in Bocking (1991).

The hatchery contribution to each year's escapement, stratified by river location and sex, was calculated by expanding the estimated number of CWT fish of each tag code group in proportion to the percentage of juvenile fish having a CWT at time of release:

$$EHC_{i,r,tc} = \frac{EST_{i,r,tc} \bullet (RM_{tc} + RUM_{tc})}{RM_{tc}} \quad (11)$$

where *EHC* is the estimated hatchery contribution, *RM* is the number of chinook released with CWT's for each tag code group (*tc*), and *RUM* is the number of chinook released without CWT's for each tag code group (tc).

These estimates of hatchery contribution by tag code were then summed to give the hatchery contribution of all tag codes to the entire escapement, stratified by river, sex, and brood year:

$$EHC_{i,r,t} = \sum_{l=1}^{j}\sum_{r=1}^{k}\sum_{t=1}^{m}\sum_{kc=1}^{n} EHC_{l,r,t,kc} \qquad (12)$$

where n is the number of tag codes for a given brood year t.

Percent hatchery contributions by sex and age were then calculated using the Petersen population estimates for adult males and females.

RESULTS

TAGGING

Carcass Tagging

In 1998, 122 chinook carcasses were tagged and released (returned to the river) between October 20 and November 17 in the Campbell River, and 531 carcasses were tagged and released from October 14 to November 23 in the Quinsam River (Table 3; Appendices 1 and 2).

RECOVERY

Surveys totalling 92.8 person days to recover carcasses in 1998 began on October 30 in the Campbell River and on October 26 in the Quinsam River and continued on until November 24 and November 30, respectively (Table 2; Figure 1; Appendices 3 and 4). On some days, some reaches in each river were surveyed more frequently than others.

Sequential daily totals of the number of carcasses recovered, the number of tags applied, and the number of tags recovered, stratified by river and sex are presented in Appendices 5 and 6. Note that the number of fish examined is greater than the number of fish examined (C) in the Petersen formula because recoveries on or before the first day of tagging were not included.

In 1998, 161 chinook carcasses were examined in the Campbell River (Table 3; Appendix 3), including 62 tag recoveries. In the Quinsam River, 1007 chinook carcasses were examined (Table 3; Appendix 4) including 295 tag recoveries.

The carcass tag recovery rates in the Campbell River (50.8%) and Quinsam River (55.5%) in 1997 were not significantly different ($P > 0.05$, χ^2; Zar 1984). The tag rates were significantly different for males (29.0%) and females (39.5%) in Campbell River and for males (53.8%) and females (43.0%) in Quinsam River ($P < 0.05$, χ^2; Zar 1984).

POPULATION ESTIMATES

Carcass Tagging

Petersen escapement estimates were stratified by river and sex (Table 4). In 1998, chinook escapement to the Campbell River and Quinsam River was estimated at 298 and 1790 adults respectively (Table 4). Sex-specific estimates and 95% confidence limits for both rivers were also calculated (Table 4). The total escapement to the Campbell/Quinsam River system in 1998, including hatchery rack recoveries, was estimated at 4,704 adults with 95% confidence limits of 4,441 and 4,967 (not including jacks and jimmies).

In 1998, the relative percentage of fish between the Campbell River, Quinsam River, and Quinsam Hatchery sampling locations was 6.3%, 47.0%, and 46.7% respectively. The percentages were 9.2%, 23.1 %, and 67.7% in 1997 (Sturhahn et al. 1999) and 29.8%, 41.4%, and 28.8% in 1996 (Nagtegaal and Graf 1998), respectively. The total estimated return of 4,704 in 1998 is the largest since the run of approx. 6,000 in 1992 and is considerably less than the high returns observed in the early 1990's (Figure 2).

AGE, LENGTH AND SEX COMPOSITION

All scale-aged fish in the Campbell and Quinsam Rivers left the river to rear in the ocean during their first year of life. Ages of all Campbell and Quinsam River chinook returns ranged from 2 to 6 years (Tables 5-8). The dominant age group in the Campbell River was age-4 yielding 58% for males and 51% for females. Fish in the Quinsam River were primarily age-3 for males and age-four for females yielding 45% and 53 % respectively. Fish returning to the Quinsam hatchery were primarily age-4 for both males as well as females ranging from 56% of males to 65% of females. The age-4 category represented > 40% for both males and females in all locations. Males in the age-3 group were most abundant in the Quinsam River composing 45 % of the return while males in this age group were less abundant in the Campbell River and Quinsam Hatchery ranging from 16.3% to 6.3% respectively.

Male and female chinook from Campbell River had larger mean lengths than male and female chinook from the Quinsam River (Campbell: male = 764 mm, female = 798 mm; Quinsam : male = 673 mm, female = 770 mm; Tables 5-8). T-tests were conducted to compare the mean lengths among sexes and among rivers. Male chinook carcasses recovered in the Quinsam River were significantly smaller than female carcasses in Quinsam River ($P < 0.001$), and were significantly smaller than both male and female carcasses in the Campbell River ($P < 0.001$). There was no significant difference between lengths of male and female carcasses recovered in Campbell River ($P > 0.05$). There was no significant difference between mean lengths of unaged and aged (all ages) chinook for any combination of sex and river stratum (t-test, $P > 0.05$).

The male/female sex proportion was found to be 0.63 for the Campbell River in 1998. The male/female sex proportions for the Quinsam River and Quinsam Hatchery were 1.86 and 1.01 respectively (Table 9).

CODED-WIRE TAGGING AND RECOVERY

Adipose-clipped (CWT) juvenile chinook releases into the Campbell and Quinsam Rivers from the 1992 to 1995 brood years were captured as adults in the dead recovery program in 1998 (Appendices 7,8, and 9). There were 57 adult CWT recoveries in Quinsam River, 189 adult CWT recoveries at the Quinsam hatchery, and three adult CWT recoveries in Campbell River. A total of 16 jack CWT recoveries were also identified from the 1995 and 1996 brood years, 15 from the Quinsam Hatchery rack and one from the Quinsam River. Two strays were identified by CWT, one from the San Juan River and one from Robertson Creek.

Hatchery release information was determined for recovered tag codes as well as hatchery contributions to escapements by tag code (Tables 10 to 13). Also, the estimated hatchery contribution to the escapement by age class can be found in Table 14.

In 1998, there were 10 adipose-clipped chinook recovered in the Campbell River dead pitch, 61 in the Quinsam River dead pitch and 289 at the hatchery rack not including jacks (Table 11). The adipose-clip mark rate was highest in hatchery returns (52.2%) and lowest in the Campbell River returns (6.2%). The mark rate for the Quinsam River was 7.0%.

Hatchery Contribution

For the purposes of this study, the actual number of CWT's present in the escapement was used to estimate the total hatchery contribution. The allocations of the total escapement of CWT's to tag codes recovered in each portion of the river are shown in Tables 11-13. The estimated hatchery contributions to the 1998 escapement of chinook (both males and females) to the Campbell River, Quinsam River, and Quinsam Hatchery were 100, 1,108, and 2,176, respectively (Table 14).

The 1998 hatchery contribution to the Campbell River population of chinook was estimated to be 22.6 % for males and 40.4 % for females (Table 14). Contribution to the in-river Quinsam chinook escapement was 49.6% for males and 42.2% for females. Fish of hatchery origin contributed 100 % of males and 70.0 % of females returning to the Quinsam Hatchery.

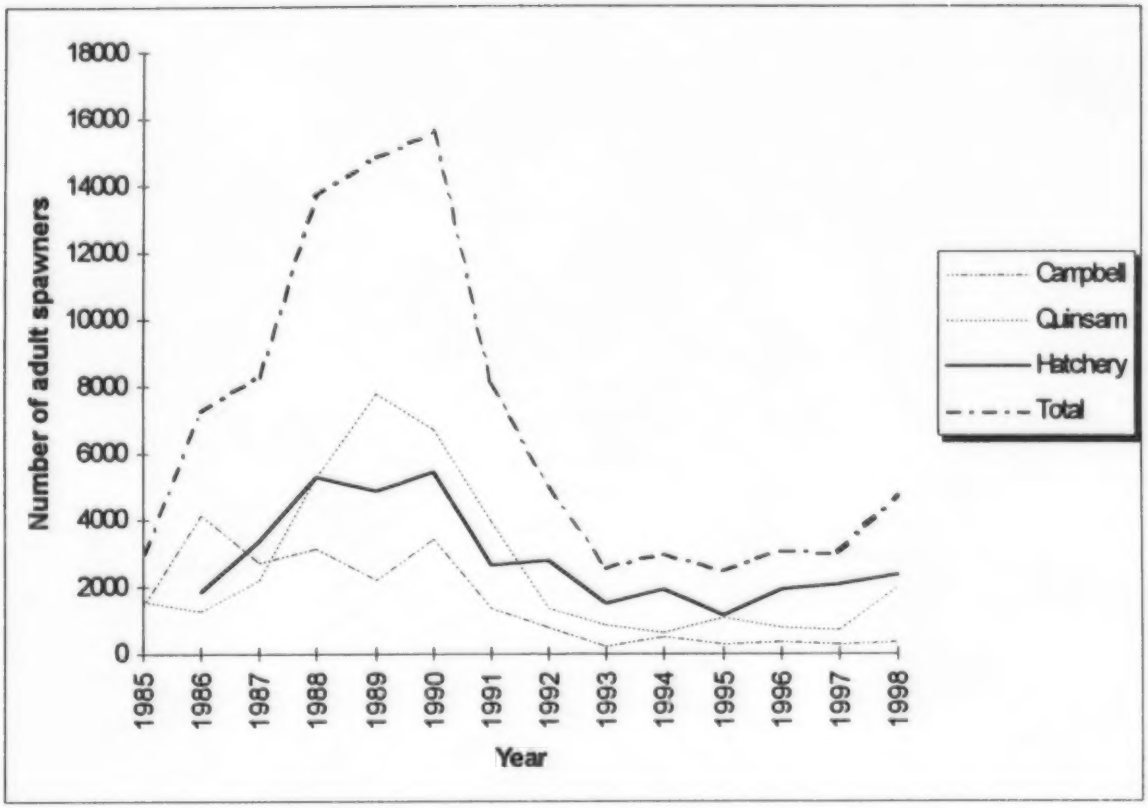

Figure 2. Chinook escapement estimates, stratified by river location, for 1985-1998 (Andrew et al. 1988; Bocking et al. 1990; Bocking 1991; Frith et al. 1993; Frith 1993; Frith and Nelson 1994; Frith and Nelson 1995; Nagtegaal and Graf 1998; Sturhahn et al. 1999, and this study).

DISCUSSION AND CONCLUSIONS

POPULATION ESTIMATION

Errors may arise as a result of differences in the abundance of chinook between sexes or river locations. Escapement estimates must be stratified in order to reduce these errors. In this study, sex ratio differences occurred in hatchery broodstock, dead recovery, and Petersen estimates. A greater number of females than males were recovered in the dead pitch survey for the Quinsam River and Campbell River whereas the number of males was greater in the Quinsam Hatchery. Andrew et al. (1988) found greater numbers of females than males in live and dead pitch recoveries in the Quinsam/Campbell system in 1986, as did Shardlow et al. (1986) in 1984-85. In years since 1986, females have dominated in Campbell and Quinsam rivers but males have dominated in Quinsam Hatchery (Bocking 1991; Frith et al. 1993). One possible explanation for the prevalence of smaller males returning to the Quinsam Hatchery is that the males tend to home in on the hatchery water supply. In addition, the hatchery fishway tends to "grade" fish as larger fish tend to avoid the fishway. As a result, the number of smaller males recovered in the hatchery is higher. This avoidance factor biases the return composition for both the Quinsam River and hatchery rack. Discrepancy between recovery rates of male/female chinook spawners also occurs in other species. Higher numbers of females than males have been observed in spawning ground dead pitches for sockeye salmon (Petersen 1954), pink salmon (Ward 1959), and coho salmon (Eames and Hino 1981; Eames et al. 1981). The number of chinook in the Quinsam Hatchery was much greater than either Quinsam or Campbell River returns (Bocking 1991; Frith et al 1993). The stratification of escapement estimates by sex and river location avoids a known source of error in the Quinsam/Campbell system and this practice should be continued for future population estimates.

It is unknown as to how completely tagged carcasses mixed with the rest of the carcass population. Incomplete mixing may have occurred in situations where tagged carcasses settled in deep pools preventing further movement. This potential bias arising from incomplete mixing is usually addressed by conducting tagging and recovery effort in proportion to the distribution of fish, by frequently moving to different tagging and recovery sites throughout both operations, and by snorkelling or SCUBA diving in deeper areas. These techniques rely on good water clarity for success.

AGE, LENGTH AND SEX COMPOSITION

In 1998, chinook escapements to the Campbell and Quinsam Rivers were composed mainly of age-4 and age-5 fish with females being slightly older. A similar age structure has been observed in recent years (Nagtegaal and Graf 1998; Sturhahn et al. 1999). The proportion of adult males to females, as determined from the Petersen estimates, was 0.63 in Campbell River and 1.86 in Quinsam River. The proportion of adult male to female returns to the Quinsam

Hatchery was 1.01. No consistent pattern of sex ratios between river locations has been observed in recent years (Frith et al. 1993; Frith and Nelson 1994; 1995). The mean length of chinook in the three river locations has remained similar over the past four years (Frith et al. 1993; Frith and Nelson 1994; 1995).

CODED-WIRE TAGGING AND RECOVERY

There were 11 recoveries in Quinsam Hatchery and three recoveries in Quinsam River of adipose-clipped chinook jacks (1996 brood). In 1998, the rate of recovery ranged from 3.1% to 10.0%. No strays were reported in 1998.

In this study, the actual number of CWT's present in the escapement was used to estimate the total hatchery contribution. Hatchery contributions ranged from 5.4 % for Campbell River females to 100% for Quinsam Hatchery males.

Although we have tried to address as many potential sources of bias as possible in the estimation of the escapement of CWT's described above, we have not explicitly included the following factors:

1. Low number of recoveries of and decoded CWT's may reduce the precision of the estimates; and
2. The sample of heads obtained for the decoding of CWT's may not be a random sample from the population and may be biased (e.g. size selectivity)

SUMMARY

1. The total escapement for chinook salmon in the Campbell/Quinsam River system using carcass tagging and hatchery returns was estimated at 4,704 in 1998 with 95 % confidence limits of 4,441 and 4,967. Estimates were stratified by river and sex.

2. Chinook returning to the Campbell River, Quinsam River, and Quinsam Hatchery ranged in age from one to six years. All fish entered salt water in their first year of life. The dominant age group for both male and female chinook returning to the Quinsam River and Quinsam Hatchery was age-4. Males returning to the Campbell River in 1998 were primarily age-4 as were females.

3. Based on the Petersen estimates and Quinsam Hatchery rack recoveries, female chinook were more abundant than males in the Campbell River while male chinook outnumbered females in the Quinsam River and Quinsam Hatchery.

4. Chinook from the Campbell River yielded the largest mean length while chinook from the Quinsam River yielded the smallest mean length. Females were significantly larger than males in the Campbell River, Quinsam River, and Quinsam Hatchery.

5. The number of actual CWT's present in the escapement to the Campbell/Quinsam system totalled 351. The total estimated return of coded-wire tagged chinook was 443.

6. The total hatchery contribution to the chinook escapement, based on CWT returns was estimated at 3,383 (71.9 %).

ACKNOWLEDGEMENTS

We would like to express our sincere appreciation to Dave Ewart and the staff of the Quinsam River hatchery that conducted the tagging and recovery effort, compiled the data, and without whom this report would not have been made possible. We would also like to recognise the work of Ed Siu and express our gratitude for his supervision of the carcass biosampling program. In addition, we would like to thank Sue Lehmann for her analysis of the coded-wire tag returns and Ted Carter for review of the manuscript.

LITERATURE CITED

Andrew, J. H., M. Lightly, and T. M. Webb. 1988. Abundance, age, size, sex and coded wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1985. Can. Manuscr. Rep. Fish. Aquat. Sci. 2007: 46 p.

Armstrong, R. W. and A. W. Argue. 1977. Trapping and coded wire tagging of wild coho and chinook juveniles from the Cowichan River system, 1975. Fish. Mar. Serv., Tech. Rep. Ser. PAC/T-77-14: 58 p.

Bell, L. M. and J. M. Thompson. 1977. The Campbell River estuary status of environmental Knowledge to 1977. Fisheries and Environment Canada, Special Estuary series No. 7, Pacific Environmental Institute, West Vancouver, BC 346 p.

Blankenship, H. L. .1990. Effects of time and fish size on coded wire tag loss from chinook and coho salmon. Proceedings of the First International Symposium on Fish Marking Techniques. Seattle, Washington. June 1988.

Bocking, R. C., K. K. English, and T. M. Webb. 1990. Abundance, age, size, sex and coded wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1986-1988. Can. Manuscr. Rep. Fish. Aquat. Sci. 2065: 126 p.

Bocking, R. C. 1991. Abundance, age, size, sex and coded wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1989-90. Can. Manuscr. Rep. Fish. Aquat. Sci. 2124: 109 p.

Eames, M. and M. Hino. 1981. A mark-recapture study of an enumerated coho spawning population. Wash. Dep. Fish. Progr. Rep. 148: 22 p.

Eames, M., I. Quinn, K. Reidinger, and D. Harling. 1981. Northern Puget Sound 1976 adult coho and chum tagging studies. Wash. Dep. Fish. Tech. Rep. 64: 217 p.

Frith, H. R. 1993. Abundance, age, size, sex and coded-wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1992. Can. Manuscr. Rep. Fish. Aquat. Sci. 2207: 56 p.

Frith, H.R., B.L. Nass, and T.C. Nelson. 1993. Abundance, age, size, sex and coded wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1991. Can. Manuscr. Rep Fish. Aquat. Sci. 2199:57 p.

Frith, H. R. and T. C. Nelson. 1994. Abundance, age, size, sex and coded wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1993. Can. MS. Rep. Fish. Aquat. Sci. 2251: 59 p.

Frith, H. R. and T. C. Nelson. 1995. Abundance, age, size, sex and coded wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1994. Can. Manuscr. Rep. Fish. Aquat. Sci. 2325: 61 p.

Gilbert, C. H. and W. H. Rich . 1927. Investigations concerning the red salmon run to the Karluk River, Alaska. Bull. U.S. Bus. Fish. 43(2): 1-69 (Doc. No 991).

Jefferts, K. B., P. K. Bergman, and H .F. Fiscus. 1963. A coded wire tag identification system for macro-organisms. Nature (London) 198: 460-462.

Kuhn, B. R. 1988. The MRP-Reporter Program: A data extraction and reporting tool for the Mark Recovery Program Database. Can. Tech. Rep. Fish. Aquat. Sci. 1625: 145 p.

Levings, C. D., C. D. McAllister, and B. D. Chang. 1986. Differential use of the Campbell Rivers Estuary, British Columbia, by wild and hatchery-reared juvenile chinook salmon (*Oncorhynchus tshawytscha*). Can. J. Fish. Aquat. Sci. 43: 1386-1397.

Marshall, D. E., R. F. Brown, V. D. Chahley, and D .G. Demontier. 1977. Preliminary catalogue of salmon streams and spawning escapements of Statistical Area 13 (Campbell River). Environment Canada. Fish. Mar. Serv. PAC/D-77-1: 176 p.

Nagtegaal, D. and G. W. F. Graf. 1998. Abundance, age, size, sex, and coded-wire tag recoveries for chinook salmon escapements of Campbell and Quinsam Rivers, 1996. Can. Manuscr. Rep. Fish. Aquat. Sci. 2448: 55 p.

Petersen, A. E. 1954. The selective action of gillnets on Fraser River sockeye salmon. Int. Pac. Salmon Fish. Comm. Bull. 5: 101 p.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 382 p.

Shardlow, T. F., T. Webb, and D. T. Lightly. 1986. Chinook salmon escapement estimation of the Campbell and Quinsam rivers in 1984: accuracy and precision of mark/recapture techniques using tagged salmon carcasses. Can. Tech. Rep. Fish. Aquat. Sci. 1507: 52 p.

Sturhahn, J. C., D.A. Nagtegaal, and M. Trenholme. 1999. Abundance, age, sex and coded-wire tag recoveries for chinook salmon escapements of Campbell and Quinsam rivers, 1997. Can. Manuscr. Rep. Fish. Aquat. Sci. 2477: 49 p.

Ward, F. J. 1959. Character of the migration of pink salmon to Fraser River spawning grounds in 1957. Int. Pac. Salmon Fish. Comm. Bull. 10: 70 p.

Zar, J. H. 1984. Biostatistical Analysis. 2nd ed. Prentice-Hall, N.Y., USA. 718 p.

Table 1. Summary of methods for the Campbell and Quinsam River chinook salmon enumeration programs, 1998.

Item	Method and Materials
Dead recovery population estimate	Peterson estimate, sum of separate estimates for sexes and rivers
Carcass tagging	Cattle ear tags(a) applied in situ to carcasses recovered in river
Secondary marking (dead)	Two-hole opercular punch for Campbell and single hole punch for Quinsam on left operculum
Recovery of fish	Foot, SCUBA surveys, snorkel surveys, rack
Coded-wire tagging (CWT)	Collection of heads from adipose clipped fish in dead recovery and at hatchery rack
Biological and physical sampling	Ages from scales and CWT, sex ratios from sex-specific population estimates for each river and at hatchery rack, postorbital-hypural length

(a) Tags were supplied by:
Ketchum Manufacturing Sales Ltd., 396 Berkely Ave., Ottawa, Ontario, K2A 2G6
(Size No. 3, 1 1/8 " x 1/4 ")

Table 2. Summary of tagging and recovery effort (person days) for chinook salmon carcasses in the Campbell and Quinsam Rivers, 1998.

	Person Days		
River	Stream walk	Diver	Total
Campbell	32.5	16	48.5
Quinsam	44.3	-	44.3
			92.8

Table 3. Summary of *in situ* carcass tagging and dead recovery of chinook salmon carcasses in Campbell and Quinsam rivers, 1998.

Category		Campbell(a)	Quinsam(b)	Total
Carcasses tagged:				
	Males	44	250	294
	Females	78	277	355
	Jacks	0	4	4
	Total	122	531	653
Carcasses				
	Males	57	503	560
	Females	103	469	572
	Jacks	1	35	36
	Total	161	1007	1168
Tags recovered (c):				
	Males	20	119	139
	Females	42	176	218
	Jacks	0	0	0
	Total	62	295	357
Tag summary:				
	Observed tag rate (%)	38.5	29.3	30.6
	Tag return rate (%)	50.8	55.6	54.7
	Tag loss (%)	0	3.7	3.1

(a) See Appendix 5 for number of carcasses recovered, number of carcasses tagged, and number of tagged recoveries, by date in Campbell River

(b) See Appendix 6 for number of carcasses recovered, number of carcasses tagged, and number of tagged recoveries, by date in Quinsam River

(c) Tagged recoveries include all carcasses with opercular punch holes (i.e. secondary marks)

Table 4. Petersen population estimates, confidence limits and enumeration data for chinook salmon escapement in the Campbell River, Quinsam River, and Quinsam Hatchery based on *in situ* chinook carcass tagging and recovery of carcasses, 1998. (Confidence limits are determined assuming R is Poisson distributed (Ricker 1975).

River and Item	Male	Female	Jack (h)	Total	
Campbell River (a)					
Number tags applied (c)	42	76	0	118	
Number recovered (d)	55	101	1	157	
Number of tagged recoveries (e)	20	42	0	62	
Petersen estimate	115	183	NA	298	(j)
Lower 95% CL	76	141	NA	217	(j)
Upper 95% CL	154	225	NA	379	(j)
Quinsam River (above fence)	512	105	51	681 (i)	
Quinsam River (b, below fence)					
Number tags applied (c)	250	277	4	531	
Number recovered (d)	502	469	35	1006	
Number of tagged recoveries (e)	119	176	0	295	
Petersen estimate	1052	738	NA	1790	(j)
Lower 95% CL	888	687	NA	1575	(j)
Upper 95% CL	1216	793	NA	2009	(j)
Quinsam Hatchery (brood stock)					
Number of fish (f)	612	768	0	1380	
Hatchery Trash/sale	180	19	81	280	
Elk Falls Channel Removal	210	210	0	420	
Total system					
Escapement	2681	2023	NA	4704 (i)	(j)
Lower 95% CL (g)	2514	1927	NA	4441	(j)
Upper 95% CL	2848	2119	NA	4967	(j)

(a) See Appendix 5 for no. of carcasses recovered, no. of carcasses tagged, and no. of tagged recoveries, by date in Campbell River

(b) See Appendix 6 for no. of carcasses recovered, no. of carcasses tagged, and no. of tagged recoveries, by date in Quinsam River

(c) Total number of fish tagged and operculum hole punched

(d) Total number of fish examined (tagged and untagged recoveries) less number of fish observed on first Day of tagging

(e) Total recoveries possessing an operculum punch (secondary mark)

(f) Confidence limits not applicable

(g) Confidence limits for the total system are proportions of a combined Petersen estimate for (a) and (b)

(h) Petersen estimates were not calculated for jacks due to low sample size

(i) Total includes 13 adults of unknown sex

(j) Totals not including jacks

Table 5. Age composition of Campbell River chinook salmon, 1998 (determined from dead recovery).

Sex and age		Unmarked	AD/CWT	Total	Percent	N	Mean length(mm)	SD	95% CL Lower	95% CL Upper
Males (a)										
3		7	0	7	16.3	7	614	41.9	583	645
4		24	1	25	58.1	25	767	59.0	743	791
5		10	1	11	25.6	11	852	51.2	822	882
	Total aged	41	2	43	100.00	43	764	76	741	787
Females										
3		2	0	2	2.3	2	685	7.1	675	695
4		42	3	45	51.1	45	755	44.1	742	768
5		29	5	34	38.6	34	846	51.3	828	863
6		7	0	7	8.0	7	879	46.0	845	913
	Total aged	80	8	88	100.00	88	798	52	787	809

(a) no jacks were observed in Campbell River in 1998.

Table 6. Age composition of Quinsam River chinook salmon, 1998.

Sex and age		Unmarked	AD/CWT	Total	Percent(b)		N	Mean Length(mm)	SD	95% CL Lower	95% CL Upper
Males (a)											
2		1	3	4	3.1		4	450	55	396	504
3		46	13	59	45.0	(46.46)	59	593	60	578	608
4		42	11	53	40.5	(41.73)	53	733	62	716	750
5		11	4	15	11.4	(11.81)	15	838	78	798	878
	Total aged	100	31	131	100.00	(100.0)	131	673	169	644	702
Females											
3		1	0	1	.6		1	700	-	-	-
4		75	16	91	53.2		90	742	48	732	752
5		65	12	77	45.0		76	821	53	809	833
6		1	1	2	1.2		2	930	14	910	950
	Total aged	142	29	171	100.00		171	770	101	755	785

(a) Jacks are included with males (four 2 yr. old fish)

(b) Figures in parentheses are age distributions in percent for adult males only (jacks are excluded)

Table 7. Age composition of Quinsam Hatchery chinook salmon, 1998.

Sex and age		Unmarked	AD/CWT	Total	Percent(b)		N	Mean Length(mm)	SD	95% CL Lower	95% CL Upper
Males (a)											
2		0	11	11	8.6		11	420	33	401	439
3		5	3	8	6.3	(6.9)	8	669	40	641	697
4		78	19	97	76.4	(83.6)	97	739	39	731	747
5		10	1	11	8.7	(9.5)	11	852	40	828	876
	Total aged	93	34	127	100.0	(100.0)	127	717	106	699	735
Females											
3		0	2	2	1.2		2	670	0	-	-
4		95	17	112	65.1		112	767	43	759	775
5		50	7	57	33.1		57	816	38	806	726
6		1	0	1	0.6		1	870	0	-	-
	Total aged	146	26	172	100.0		172	782	49	775	789

(a) Jacks are included with males (11 age 2)

(b) Figures in parentheses are age distributions in percent for adult males only (jacks are excluded)

Table 8. Age-length distribution of Campbell River, Quinsam River, and Quinsam Hatchery chinook salmon, 1998.

Location	Length class (mm)	Age												
		Males							Females					
		1	2	3	4	5	6	Total	2	3	4	5	6	Total
Campbell River														
	250-299	0	0	0	0	0	0	0	0	0	0	0	0	0
	300-349	0	0	0	0	0	0	0	0	0	0	0	0	0
	350-399	0	0	0	0	0	0	0	0	0	0	0	0	0
	400-449	0	0	0	0	0	0	0	0	0	0	0	0	0
	450-499	0	0	0	0	0	0	0	0	0	0	0	0	0
	500-549	0	0	1	0	0	0	1	0	0	0	0	0	0
	550-599	0	0	0	0	0	0	0	0	0	0	0	0	0
	600-649	0	0	5	1	0	0	6	0	0	0	0	0	0
	650-699	0	0	1	2	0	0	3	0	2	4	0	0	6
	700-749	0	0	0	8	0	0	8	0	0	18	1	0	19
	750-799	0	0	0	7	1	0	8	0	0	14	4	1	19
	800-849	0	0	0	6	5	0	11	0	0	9	14	0	23
	850-899	0	0	0	1	1	0	2	0	0	0	9	4	13
	900-949	0	0	0	0	4	0	4	0	0	0	5	2	7
	950-999	0	0	0	0	0	0	0	0	0	0	1	0	1
	1000-1049	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mean	0	0	614	767	852	0	764	0	685	755	846	879	798
	SD	0	0	41.9	59.0	51.2	0	76	0	7.1	44.1	51.3	46.0	52
	N	0	0	7	25	11	0	43	0	2	45	34	7	88
Quinsam River														
	250-299	0	0	0	0	0	0	0	0	0	0	0	0	0
	300-349	0	0	0	0	0	0	0	0	0	0	0	0	0
	350-399	0	1	0	0	0	0	1	0	0	0	0	0	0
	400-449	0	0	0	0	0	0	0	0	0	0	0	0	0
	450-499	0	3	1	0	0	0	4	0	0	0	0	0	0
	500-549	0	0	14	0	0	0	14	0	0	0	0	0	0
	550-599	0	0	15	1	0	0	16	0	0	0	0	0	0
	600-649	0	0	17	2	0	0	19	0	0	3	0	0	3
	650-699	0	0	10	11	0	0	21	0	0	11	3	0	14
	700-749	0	0	1	18	4	0	23	0	1	40	6	0	47
	750-799	0	0	1	13	0	0	14	0	0	25	9	0	34
	800-849	0	0	0	8	4	0	12	0	0	10	33	0	43
	850-899	0	0	0	0	2	0	2	0	0	2	21	0	23
	900-949	0	0	0	0	4	0	4	0	0	0	5	2	7
	950-999	0	0	0	0	1	0	1	0	0	0	0	0	0
	1000-1049	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mean	0	450	593	733	838	0	673	0	700	742	821	930	770
	SD	0	55	60	62	78	0	169	0	-	48	53	14	101
	N	0	4	59	53	15	0	131	0	1	90	76	2	171

Table 8 (cont'd)

Length Class (mm)	Males 1	2	3	4	5	6	Total	Females 2	3	4	5	6	Total
Quinsam Hatchery													
150-199	0	0	0	0	0	0	0	0	0	0	0	0	0
200-249	0	0	0	0	0	0	0	0	0	0	0	0	0
250-299	0	0	0	0	0	0	0	0	0	0	0	0	0
300-349	0	0	0	0	0	0	0	0	0	0	0	0	0
350-399	0	3	0	0	0	0	3	0	0	0	0	0	0
400-449	0	5	0	0	0	0	5	0	0	0	0	0	0
450-499	0	3	0	0	0	0	3	0	0	0	0	0	0
500-549	0	0	0	0	0	0	0	0	0	0	0	0	0
550-599	0	0	0	0	0	0	0	0	0	0	0	0	0
600-649	0	0	2	2	0	0	4	0	0	0	0	0	0
650-699	0	0	4	13	0	0	17	0	2	5	0	0	7
700-749	0	0	2	39	0	0	41	0	0	30	1	0	31
750-799	0	0	0	38	1	0	39	0	0	54	19	0	73
800-849	0	0	0	4	4	0	8	0	0	21	26	0	47
850-899	0	0	0	1	5	0	6	0	0	2	11	1	14
900-949	0	0	0	0	1	0	1	0	0	0	0	0	0
950-999	0	0	0	0	0	0	0	0	0	0	0	0	0
1000-1049	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	-	420	669	739	852	-	717	0	670	767	816	870	782
SD	0	33	40	39	40	-	106	0	0	43	38	0	49
N	0	11	8	97	11	-	127	0	2	112	57	1	172

Table 9. Petersen estimates, by age, of chinook salmon escapement to the Campbell River, Quinsam River, and Quinsam Hatchery, 1998.

Age	Males (a)		Females	
	Number (b)	Percent (c)	Number (b)	Percent (c)
Campbell River				
3	19	16.3	4	2.3
4	67	58.1	94	51.1
5	29	25.6	71	38.6
6	0	0.0	14	8.0
Total	115 (d)	100.00	183 (d)	100.00
Quinsam River (e)				
3	727	46.5	5	0.6
4	654	41.8	449	53.2
5	183	11.7	379	45.0
6	0	0.0	10	1.2
Total	1564(d)	100.00	843(d)	100.00
Quinsam Hatchery (f)				
3	69	6.9	12	1.2
4	838	83.6	649	65.1
5	95	9.5	330	33.1
6	0	0.0	6	0.6
Total	1002(d)	100.00	997(d)	100.00

(a) Does not include jacks; see table 4 footnote (h)

(b) Number of fish by age are calculated from the product of the percentage age (c) and total adult escapement (d)

(c) Percentage age distribution from tables 5,6 and 7

(d) Petersen estimates or Quinsam Hatchery recoveries from Table 4

(e) Includes fish released above the fence as well as a Petersen estimate for below the fence

(f) Includes hatchery brood stock, hatchery trash/sale, and Elk Falls channel removal

Table 10. CWT release data for hatchery-reared chinook salmon returning to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1998.

Brood Year	CWT Code	Release Numbers		CWT loss(%)	CWT mark(%)	Days held
		CWT	Untagged			
1996	182509	23,689	508,887	12.4	4.4	24
	182510	28,465	246,295	16.5	8	23
	182513	28,013	264,114	0.4	9.6	25
	182514	28,770	274,166	0.7	9.5	23
	182515	28,914	186,338	0.0	13.4	21
	182518	27,933	191,652	4.1	12.7	27
1995	182018	25,587	108,783	3.7	19	53
	182016	25,543	104,936	1.6	19.6	58
	182021	26,084	191,498	0	12	37
	182020	26,187	188,677	0.5	12.2	35
	181660	26,620	211,977	0.2	11.2	38
	181659	26,388	209,831	0.2	11.2	37
	181658	24,689	208,476	2.4	10.6	32
	182022	25,392	507,932	0.6	4.8	21
	182017	25,494	24,736	1.9	50.8	28
	182019	25,561	243,362	3.3	9.5	30
	181661	26,120	121,352	1.1	17.7	21
	182024	50,141	581,216	0.0	8.63	-
1994	181644	25,528	85,223	4.6	23	34
	181645	25,946	80,280	2.6	24.4	32
	181646	26,471	193,017	0.6	12.1	29
	181647	26,470	189,087	0.6	12.3	25
	181648	26,529	184,863	0.7	12.5	23
	181649	26,438	192,831	0.4	12.1	21
	181652	26,770	274,401	0.3	8.9	20
	181651	26,375	267,688	0.6	9.0	26
	181650	26,397	126,362	0.7	17.3	28
	020960	24,880	204,284	0.0	10.9	24
	020961	24,769	204,881	0.4	10.8	22
	020963	26,023	224,406	0.4	10.4	17

Table 10 (cont'd)

Brood Year	CWT Code	Release Numbers		CWT loss(%)	CWT mark(%)	Days held
		CWT	Untagged			
1993	181356	26,204	63,724	1.0	29.1	19
	180628	25,362	205,743	0.6	11	9
	181357	26,140	78,365	2.0	25	16
	181358	26,574	81,724	1.2	24.5	14
	181359	25,147	174,609	0.1	12.6	10
	180629	26,632	115,968	0.6	18.7	15
	181360	25,631	180,326	0.3	12.4	9
	181362	26,370	188,110	0.2	12.3	10
	181425	50,700	699,300	0	6.8	1
	180631	26,719	259,036	0.0	9.4	12
	181361	26,115	177,005	0.2	12.9	11
	180630	26,322	262,885	0.2	9.1	13
1992	181154	23,689	242,773	5.8	8.9	21

Table 11. Estimates of the adjusted number of CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1998.

Brood year	CWT code	Campbell River (a,b) Observed CWT's M	F	Campbell River (a,b) Adjusted CWT's M	F	Quinsam River (a,b) Observed CWT's M	F	Quinsam River (a,b) Adjusted CWT's M	F	Quinsam Hatchery (a,b) Observed CWT's M	F	Quinsam Hatchery (a,b) Adjusted CWT's M	F	Total (a,b) Observed CWT's M	F	Total (a,b) Adjusted (c) CWT's M	F
1995	181658	0	0	0.00	0.00	1	0	1.00	0.00	8	0	8.00	0.00	9	0	9.00	0.00
	181659	0	0	0.00	0.00	2	0	2.00	0.00	3	0	3.00	0.00	5	0	5.00	0.00
	181660	0	0	0.00	0.00	2	0	2.00	0.00	10	1	10.00	1.00	12	1	12.00	1.00
	181661	0	0	0.00	0.00	0	0	0.00	0.00	1	0	1.00	0.00	1	0	1.00	0.00
	182016	0	0	0.00	0.00	2	0	2.00	0.00	9	1	9.00	1.00	11	1	11.00	1.00
	182017	0	0	0.00	0.00	1	0	1.00	0.00	14	0	14.00	0.00	15	0	15.00	0.00
	182018	0	0	0.00	0.00	0	0	0.00	0.00	5	0	5.00	0.00	5	0	5.00	0.00
	182019	0	0	0.00	0.00	1	0	1.00	0.00	5	0	5.00	0.00	6	0	6.00	0.00
	182020	0	0	0.00	0.00	1	0	1.00	0.00	6	0	6.00	0.00	7	0	7.00	0.00
	182021	0	0	0.00	0.00	1	0	1.00	0.00	13	0	13.00	0.00	14	0	14.00	0.00
	182022	0	0	0.00	0.00	1	0	1.00	0.00	12	0	12.00	0.00	13	0	13.00	0.00
	182024	0	0	0.00	0.00	1	0	1.00	0.00	0	0	0.00	0.00	1	0	1.00	0.00
	Subtotal	0	0	0.00	0.00	13	0	13.00	0.00	86	2	86.00	2.00	99	2	99.00	2.00
1994	20960	0	0	0.00	0.00	0	2	0.00	2.00	1	2	1.00	2.00	1	4	1.00	4.00
	20961	0	0	0.00	0.00	0	2	0.00	2.00	2	1	2.00	1.00	2	3	2.00	3.00
	20963	0	0	0.00	0.00	0	1	0.00	1.00	4	2	4.00	2.00	4	3	4.00	3.00
	181644	0	1	0.00	1.00	1	2	1.00	2.00	8	14	8.00	14.00	9	17	9.00	17.00
	181645	1	0	1.00	0.00	1	1	1.00	1.00	16	12	16.00	12.00	18	13	18.00	13.00
	181646	0	0	0.00	0.00	2	0	2.00	0.00	9	9	9.00	9.00	11	9	11.00	9.00
	181647	0	0	0.00	0.00	2	3	2.00	3.00	13	8	13.00	8.00	15	11	15.00	11.00
	181458	0	1	0.00	1.00	0	0	0.00	0.00	0	0	0.00	0.00	0	1	0.00	1.00
	181648	0	0	0.00	0.00	0	0	0.00	0.00	9	8	9.00	8.00	9	8	9.00	8.00
	181649	0	0	0.00	0.00	2	2	2.00	2.00	6	5	6.00	5.00	8	7	8.00	7.00
	181650	0	1	0.00	1.00	0	2	0.00	2.00	9	5	9.00	5.00	9	8	9.00	8.00
	181651	0	0	0.00	0.00	1	1	1.00	1.00	10	6	10.00	6.00	11	7	11.00	7.00
	181652	0	0	0.00	0.00	2	0	2.00	0.00	5	3	5.00	3.00	7	3	7.00	3.00
	Subtotal	1	3	1.00	3.00	11	16	11.00	16.00	92	75	92.00	75.00	104	94	104.00	94.00

Table 11 (cont'd)

Brood year	CWT code	Campbell River (a,b) Observed CWT's M	F	Campbell River (a,b) Adjusted CWT's M	F	Quinsam River (a,b) Observed CWT's M	F	Quinsam River (a,b) Adjusted CWT's M	F	Quinsam Hatchery (a,b) Observed CWT's M	F	Quinsam Hatchery (a,b) Adjusted CWT's M	F	Total (a,b) Observed CWT's M	F	Total (a,b) Adjusted (c) CWT's M	F
1993	180628	1	0	1.00	0.00	1	0	1.00	0.00	0	0	0.00	0.00	2	0	2.00	0.00
	180629	0	0	0.00	0.00	1	3	1.00	3.00	2	2	2.00	2.00	3	5	3.00	5.00
	180630	0	0	0.00	0.00	0	0	0.00	0.00	0	3	0.00	3.00	0	3	0.00	3.00
	180631	0	0	0.00	0.00	1	0	1.00	0.00	0	0	0.00	0.00	1	0	1.00	0.00
	181356	0	1	0.00	1.00	0	1	0.00	1.00	1	5	1.00	5.00	1	7	1.00	7.00
	181357	0	1	0.00	1.00	0	4	0.00	4.00	0	1	0.00	1.00	0	6	0.00	6.00
	181358	0	0	0.00	0.00	0	1	0.00	1.00	0	2	0.00	2.00	0	3	0.00	3.00
	181359	0	0	0.00	0.00	0	0	0.00	0.00	0	1	0.00	1.00	0	1	0.00	1.00
	181360	0	1	0.00	1.00	0	3	0.00	3.00	1	3	1.00	3.00	1	7	1.00	7.00
	181361	0	1	0.00	1.00	1	0	1.00	0.00	0	1	0.00	1.00	1	2	1.00	2.00
	181362	0	1	0.00	1.00	0	0	0.00	0.00	1	5	1.00	5.00	1	6	1.00	6.00
	181425	0	0	0.00	0.00	0	0	0.00	0.00	1	0	1.00	0.00	1	0	1.00	0.00
	Subtotal	1	5	1.00	5.00	4	12	4.00	12.00	6	23	6.00	23.00	11	40	11.00	40.00
1992	181154	0	0	0.00	0.00	0	1	0.00	1.00	0	0	0.00	0.00	0	1	0.00	1.00
	Subtotal	0	0	0.00	0.00	0	1	0.00	1.00	0	0	0.00	0.00	0	0	0.00	1.00
Total Hatchery		2	8	2.00	8.00	28	29	28.00	29.00	184	100	184.00	100.00	214	137	214.00	137.00
Total CWT		2	8	2.00	8.00	28	29	28.00	29.00	184	100	184.00	100.00	214	137	214.00	137.00
No data (5000)		0	0			1	0			0	0			1	0		
No pin (8000)		0	0			2	1			3	1			5	2		
Lost pin (9000)		0	0			0	0			1	0			1	0		
Observed adipose		2	8			31	30			188	101			221	139		

(a) Abbreviations are M = male, F = female

(b) Does not include jacks

(c) Two decimal places are carried for the adjusted CWT's in order to calculate the expanded hatchery contribution in Table 13

Table 12. Estimates of the total escapement of CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1998.

Brood year	CWT code	Campbell River (a,b) Adjusted(e) CWT's M	F	Campbell River (a,b) Estimated CWT's M	F	Quinsam River (a,b) Adjusted (e) CWT's M	F	Quinsam River (a,b) Estimated CWT's M	F	Quinsam Hatchery (a,b) Adjusted (e) CWT's M	F	Quinsam Hatchery (a,b) Estimated CWT's M	F	Total (a,b) Adjusted (e) CWT's M	F	Total (a,b) Estimated CWT's M	F
1995	181658	0.00	0.00	0.00	0.00	1.00	0.00	3.11	0.00	8.00	0.00	8.00	0.00	9.00	0.00	11.11	0.00
	181659	0.00	0.00	0.00	0.00	2.00	0.00	6.22	0.00	3.00	0.00	3.00	0.00	5.00	0.00	9.22	0.00
	181660	0.00	0.00	0.00	0.00	2.00	0.00	6.22	0.00	10.00	1.00	10.00	1.00	12.00	1.00	16.22	1.00
	181661	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
	182016	0.00	0.00	0.00	0.00	2.00	0.00	6.22	0.00	9.00	1.00	9.00	1.00	11.00	1.00	15.22	1.00
	182017	0.00	0.00	0.00	0.00	1.00	0.00	3.11	0.00	14.00	0.00	14.00	0.00	15.00	0.00	17.11	0.00
	182018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	5.00	0.00	5.00	0.00	5.00	0.00
	182019	0.00	0.00	0.00	0.00	1.00	0.00	3.11	0.00	5.00	0.00	5.00	0.00	6.00	0.00	8.11	0.00
	182020	0.00	0.00	0.00	0.00	1.00	0.00	3.11	0.00	6.00	0.00	6.00	0.00	7.00	0.00	9.11	0.00
	182021	0.00	0.00	0.00	0.00	1.00	0.00	3.11	0.00	13.00	0.00	13.00	0.00	14.00	0.00	16.11	0.00
	182022	0.00	0.00	0.00	0.00	1.00	0.00	3.11	0.00	12.00	0.00	12.00	0.00	13.00	0.00	15.11	0.00
	182024	0.00	0.00	0.00	0.00	1.00	0.00	3.11	0.00	0.00	0.00	0.00	0.00	1.00	0.00	3.11	0.00
	Subtotal	0.00	0.00	0.00	0.00	13.00	0.00	40.42	0.00	86.00	2.00	86.00	2.00	99.00	2.00	126.43	2.00
1994	20960	0.00	0.00	0.00	0.00	0.00	2.00	0.00	3.59	1.00	2.00	1.00	2.00	1.00	4.00	1.00	5.59
	20961	0.00	0.00	0.00	0.00	0.00	2.00	0.00	3.59	2.00	1.00	2.00	1.00	2.00	3.00	2.00	4.59
	20963	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.80	4.00	2.00	4.00	2.00	4.00	3.00	4.00	3.80
	181644	0.00	1.00	0.00	1.78	1.00	2.00	3.11	3.59	8.00	14.00	8.00	14.00	9.00	17.0	11.11	19.37
	181645	1.00	0.00	2.02	0.00	1.00	1.00	3.11	1.80	16.00	12.00	16.00	12.00	18.00	13.0	21.13	13.80
	181646	0.00	0.00	0.00	0.00	2.00	0.00	6.22	0.00	9.00	9.00	9.00	9.00	11.00	9.00	15.22	9.00
	181647	0.00	0.00	0.00	0.00	2.00	3.00	6.22	5.40	13.00	8.00	13.00	8.00	15.00	11.0	19.22	13.40
	181458	0.00	1.00	0.00	1.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.78
	181648	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00	8.00	9.00	8.00	9.00	8.00	9.00	8.00
	181649	0.00	0.00	0.00	0.00	2.00	2.00	6.22	3.59	6.00	5.00	6.00	5.00	8.00	7.00	12.22	8.59
	181650	0.00	1.00	0.00	1.78	0.00	2.00	0.00	3.59	9.00	5.00	9.00	5.00	9.00	8.00	9.00	10.37
	181651	0.00	0.00	0.00	0.00	1.00	1.00	3.11	1.80	10.00	6.00	10.00	6.00	11.00	7.00	13.11	7.80
	181652	0.00	0.00	0.00	0.00	2.00	0.00	6.22	0.00	5.00	3.00	5.00	3.00	7.00	3.00	11.22	3.00
	Subtotal	1.00	3.00	2.02	5.33	11.00	16.00	34.20	28.76	92.00	75.00	92.00	75.00	104.00	94.0	128.23	109.09

Table 12 (cont'd)

Brood year	CWT code	Campbell River (a,b) Adjusted(e) CWT's M	F	Campbell River (a,b) Estimated CWT's M	F	Quinsam River (a,b) Adjusted(e) CWT's M	F	Quinsam River (a,b) Estimated CWT's M	F	Quinsam Hatchery (a,b) Adjusted(e) CWT's M	F	Quinsam Hatchery (a,b) Estimated CWT's M	F	Total (a,b) Adjusted(e) CWT's M	F	Total (a,b) Estimated CWT's M	F
1993	180628	1.00	0.00	2.02	0.00	1.00	0.00	3.11	0.00	0.00	0.00	0.00	0.00	2.00	0.00	5.13	0.00
	180629	0.00	0.00	0.00	0.00	1.00	3.00	3.11	5.39	2.00	2.00	2.00	2.00	3.00	5.00	5.11	7.39
	180630	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	3.00	0.00	3.00	0.00	3.00
	180631	0.00	0.00	0.00	0.00	1.00	0.00	3.11	0.00	0.00	0.00	0.00	0.00	1.00	0.00	3.11	0.00
	181356	0.00	1.00	0.00	1.78	0.00	1.00	0.00	1.80	1.00	5.00	1.00	5.00	1.00	7.00	1.00	8.58
	181357	0.00	1.00	0.00	1.78	0.00	4.00	0.00	7.20	0.00	1.00	0.00	1.00	0.00	6.00	0.00	9.98
	181358	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.80	0.00	2.00	0.00	2.00	0.00	3.00	0.00	3.8
	181359	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
	181360	0.00	1.00	0.00	1.78	0.00	3.00	0.00	5.39	1.00	3.00	1.00	3.00	1.00	7.00	1.00	10.17
	181361	0.00	1.00	0.00	1.78	1.00	0.00	3.11	0.00	0.00	1.00	0.00	1.00	1.00	2.00	3.11	2.78
	181362	0.00	1.00	0.00	1.78	0.00	0.00	0.00	0.00	1.00	5.00	1.00	5.00	1.00	6.00	1.00	6.78
	181425	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
	Subtotal	1.00	5.00	2.02	8.88	4.00	12.00	12.44	21.57	6.00	23.00	6.00	23.00	11.00	40.00	20.46	53.45
1992	181154	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.80	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.80
	Subtotal	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.80	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.80
Total Hatchery		2.0	8.0	4.04	14.21	28.0	30.0	87.06	53.92	184.0	100.0	184.0	100.0	214.0	138.0	275.10	168.13
Petersen est. (c)		115	183			1564	843			1002	997						
Sample size (d)		57	103			503	469			1002	997						

(a) Abbreviations are M = male, F = female
(b) Does not include jacks
(c) From Table 9
(d) Campbell River data from Appendix 7; Quinsam River data from Appendix 8; Quinsam Hatchery data from unsummarized recovery data base
(e) Two decimal places are carried for the adjusted CWT's in order to calculate the expanded hatchery contribution in Table 13

Table 13. Estimates of total escapement of hatchery-reared CWT chinook salmon to the Campbell River, Quinsam River, and Quinsam Hatchery, by tag code, 1998.

Brood year	CWT release group	Release Numbers (c)		Expansion Factor (c)	Expanded hatchery contributions (a,b)							
					Campbell River		Quinsam River		Quinsam hatchery		Total	
		CWT	Untagged (d)		M	F	M	F	M	F	M	F
1995	181658	24,689	208,476	9.4	0.00	0.00	29.23	0.00	75.20	0.00	104.43	0.00
	181659	26,388	209,831	9.0	0.00	0.00	55.98	0.00	27.00	0.00	82.98	0.00
	181660	26,620	211,977	9.0	0.00	0.00	55.98	0.00	90.00	9.00	145.98	9.00
	181661	26,120	121,352	5.6	0.00	0.00	0.00	0.00	5.60	0.00	5.60	0.00
	182016	25,543	104,936	5.1	0.00	0.00	31.72	0.00	45.9	5.10	77.62	5.10
	182017	25,494	24,736	2.0	0.00	0.00	6.22	0.00	28.00	0.00	34.22	0.00
	182018	25,587	108,783	5.3	0.00	0.00	0.00	0.00	26.50	0.00	26.50	0.00
	182019	25,561	243,362	10.5	0.00	0.00	32.66	0.00	52.50	0.00	85.16	0.00
	182020	26,187	188,677	8.2	0.00	0.00	25.50	0.00	49.20	0.00	74.70	0.00
	182021	26,084	191,498	8.3	0.00	0.00	25.81	0.00	107.90	0.00	133.71	0.00
	182022	25,392	507,932	21.0	0.00	0.00	65.31	0.00	252.00	0.00	317.31	0.00
	182024	25,653	271,707	11.6	0.00	0.00	36.08	0.00	0.00	0.00	36.08	0.00
	Subtotal	309,318	2,393,267		0.00	0.00	364.49	0.00	759.80	14.10	1124.2	14.10
1994	20960	24,880	204,284	9.2	0.00	0.00	0.00	33.03	9.20	18.40	9.20	51.43
	20961	24,769	204,881	9.3	0.00	0.00	0.00	33.39	18.60	9.30	18.60	42.69
	20963	26,086	224,406	9.6	0.00	0.00	0.00	17.28	38.40	19.20	38.40	36.48
	181644	25,528	85,223	4.3	0.00	7.65	13.37	15.44	34.40	60.20	47.77	83.29
	181645	25,946	80,280	4.1	8.28	0.00	12.75	7.38	65.60	49.20	86.63	56.58
	181646	26,471	193,017	8.3	0.00	0.00	51.63	0.00	74.70	74.70	126.33	74.70
	181647	26,470	189,087	8.1	0.00	0.00	50.38	43.74	105.30	64.80	155.68	108.54
	181648	26,529	184,863	8.0	0.00	0.00	0.00	0.00	72.00	64.00	72.00	64.00
	181649	26,438	192,831	8.3	0.00	0.00	51.63	29.80	49.80	41.50	101.43	71.30
	181650	26,397	126,362	5.8	0.00	10.32	0.00	20.82	52.20	29.00	52.20	60.14
	181651	26,375	267,688	11.1	0.00	0.00	34.52	19.98	111.00	66.60	145.52	86.58
	181652	26,770	274,401	11.3	0.00	0.00	70.29	0.00	56.5	33.90	126.79	33.90
	Subtotal	312,659	2,227,323		8.28	17.97	284.57	220.86	687.70	530.80	980.55	769.34

Table 13 (cont'd)

Brood year	CWT release group	Release Numbers CWT	Release Numbers Untagged	Expansion Factor (c)	Expanded hatchery contributions (a,b) Campbell River M	Campbell River F	Quinsam River M	Quinsam River F	Quinsam Hatchery M	Quinsam Hatchery F	Total M	Total F
1993	180628	25,362	205,743	9.1	18.38	0.00	28.30	0.00	0.00	0.00	46.68	0.00
	180629	26,632	115,968	5.4	0.00	0.00	16.79	29.11	10.80	10.80	27.59	39.91
	180630	26,322	262,885	11.0	0.00	0.00	0.00	0.00	0.00	33.00	0.00	33.00
	180631	26,719	259,036	10.7	0.00	0.00	33.23	0.00	0.00	0.00	33.23	0.00
	181356	26,204	63,724	3.4	0.00	6.05	0.00	6.12	3.40	17.00	3.40	29.17
	181357	26,140	78,365	4.0	0.00	7.12	0.00	28.8	0.00	4.00	0.00	39.92
	181358	26,574	81,724	4.1	0.00	0.00	0.00	7.38	0.00	8.20	0.00	15.58
	181359	25,147	174,609	7.9	0.00	0.00	0.00	0.00	0.00	7.90	0.00	7.90
	181360	25,631	180,326	8.0	0.00	14.24	0.00	43.12	8.00	24.00	8.00	81.36
	181361	26,115	177,005	7.8	0.00	13.88	24.26	0.00	0.00	7.80	24.26	21.68
	181362	26,370	188,110	8.1	0.00	14.42	0.00	0.00	8.10	40.50	8.10	54.92
	Subtotal	287,216	1,787,495		18.38	55.71	102.58	114.535	30.30	153.20	151.26	323.44
1992	181154	23,689	242,773	11.2	0.00	0.00	0.00	20.16	0.00	0.00	0.00	20.16
	Subtotal	23,689	242,773		0.00	0.00	0.00	20.16	0.00	0.00	0.00	20.16
Total Hatchery					26.66	73.68	751.64	355.55	1477.80	698.10	2256.0	1127.04

(a) Abbreviations are M = male, F = female
(b) Does not include jacks
(c) The expansion factor is used to expand the estimated number of CWT chinook in the escapement to account for unmarked hatchery releases and, hence, derive hatchery contributions to escapement ; Expansion factor = (CWT releases + untagged releases)/CWT releases
(d) Untagged = AD only (i.e. tag lost) + unmarked (i.e. no CWT/AFC applied)

Table 14. Estimated hatchery and stray contributions to Campbell River, Quinsam River, and Quinsam Hatchery chinook salmon escapement, 1998.

		Estimated escapement (a)		Hatchery contribution (b)				Stray contribution (b)			
				Male (c)		Female		Male (c)		Female	
	Age	Male (c)	Female	Number	%	Number	%	Number	%	Number	%
Campbell River											
	3	19	4	0	0.0	0	0.0	0	0.0	0	0.0
	4	67	94	8	11.9	18	19.1	0	0.0	1	1.1
	5	29	71	18	62.1	56	78.9	0	0.0	0	0.0
	6	0	14	0	0.0	0	0.0	0	0.0	0	0.0
	Total	115	183	26	22.6	74	40.4	0	0.0	1	.55
Quinsam River											
	3	704	5	364	51.7	0	0.0	0	0.0	0	0.0
	4	633	449	285	45.0	221	49.2	0	0.0	0	0.0
	5	178	379	103	57.9	115	30.3	0	0.0	0	0.0
	6	0	10	0	0.0	20	100(d)	0	0.0	0	0.0
	Total	1515	843	752	49.6	356	42.2	0	0.0	0	0.0
Quinsam Hatchery											
	3	63	12	760	100(d)	14	100(d)	0	0.0	0	0.0
	4	766	649	688	89.8	531	81.8	0	0.0	0	0.0
	5	87	330	30	34.5	153	46.4	1	1.1	0	0.0
	6	0	6	0	0.0	0	0.0	0	0.0	0	0.0
	Total	916	997	1478	100(d)	698	70.0	1	.11	0	0.0

(a) From Table 9
(b) Contributions were calculated using CWT expansion for the estimated number of CWT's (Table 13)
(c) Does not include jacks
(d) Estimated hatchery contribution greater than 100%

APPENDICES

Appendix 1. Staple tagging of chinook salmon carcasses in Campbell River, 1998. [1]

Date	Capture area (a)	Tagged			
		Male	Female	Jack	Total
20-Oct	1B	2	2	0	4
23-Oct	1A	1	0	0	1
23-Oct	1B	2	4	0	6
27-Oct	CHB	1	1	0	2
27-Oct	1C	4	8	0	12
28-Oct	CHB	2	1	0	3
28-Oct	1A	1	3	0	4
30-Oct	1B	6	10	0	16
30-Oct	CHB	1	1	0	2
3-Nov	1B	5	10	0	15
3-Nov	1A	4	11	0	15
3-Nov	CHA	5	3	0	8
3-Nov	CHB	0	1	0	1
4-Nov	CHB	1	6	0	7
4-Nov	1B	2	0	0	2
4-Nov	1A	0	2	0	2
6-Nov	1B	2	2	0	4
6-Nov	1A	0	2	0	2
10-Nov	1B	1	3	0	4
10-Nov	CHB	1	1	0	2
10-Nov	1A	0	1	0	1
13-Nov	1A	0	2	0	2
17-Nov	1B	3	3	0	6
17-Nov	CHB	0	1	0	1
Total		44	78	0	122

[1] The spawning channel was divided into three sections. CH A is the top 1/3, CH B is the middle 1/3, and CH C is the bottom 1/3 of the channel. See Figure 1 for the locations of capture areas.

Appendix 2. Staple tagging of chinook salmon carcasses in Quinsam River, 1998. *

Date	Capture Area	Tagged			
		Male	Female	Jack	Total
14-Oct	2D	0	1	0	1
15-Oct	2D	1	0	0	1
21-Oct	2C	0	2	0	2
21-Oct	2D	3	0	0	3
22-Oct	2D	3	8	0	11
26-Oct	2B	3	2	0	5
26-Oct	2C	5	1	0	6
26-Oct	2D	5	5	0	10
29-Oct	2D	6	11	0	17
29-Oct	2C	10	4	0	14
29-Oct	2B	5	7	0	12
2-Nov	2B	7	6	1	14
2-Nov	2C	18	23	0	41
2-Nov	2D	10	17	0	27
5-Nov	2B	10	9	0	19
5-Nov	2C	21	29	0	50
5-Nov	2D	9	27	0	36
6-Nov	2D	0	2	0	2
9-Nov	2B	16	14	0	30
9-Nov	2C	41	59	2	102
9-Nov	2D	4	3	0	7
11-Nov	2D	5	11	1	17
12-Nov	2B	12	9	0	21
12-Nov	2C	26	17	0	43
12-Nov	2D	1	0	0	1
16-Nov	2B	5	0	0	5
16-Nov	2C	2	3	0	5
16-Nov	2D	2	0	0	2
18-Nov	2C	6	2	0	8
19-Nov	2B	5	2	0	7
19-Nov	2C	4	2	0	6
23-Nov	2B	2	0	0	2
23-Nov	2C	1	0	0	1
23-Nov	2D	2	1	0	3
Total		250	277	4	531

* See Figure 1 for location of captures areas.

Appendix 3. Recovery of tagged chinook salmon carcasses in Campbell River, 1998.

Date	Recovery area (a)	Recovered(a)			
		Male	Female	Jack	Total
30-Oct	1A	1	1	0	2
30-Oct	1B	1	0	0	1
3-Nov	1A	0	2	0	2
3-Nov	1B	3	7	0	10
3-Nov	CHB	1	2	0	3
6-Nov	1A	1	5	0	6
6-Nov	1B	2	5	0	7
6-Nov	CHA	1	1	0	2
10-Nov	1A	1	1	0	2
10-Nov	1B	5	5	0	10
10-Nov	CHB	1	3	0	4
13-Nov	1B	1	1	0	2
13-Nov	CHA	0	3	0	3
17-Nov	1A	0	1	0	1
18-Nov	CHB	1	3	0	4
20-Nov	CHB	1	1	0	2
24-Nov	1B	0	1	0	1
Total		20	42	0	62

(a) See Figure 1 for location of recovery areas

Appendix 4. Recovery of tagged chinook salmon carcasses in Quinsam River, 1998.

Date	Recovery area (a)	Recovered (a)			
		Male	Female	Jack	Total
26-Oct	2D	1	3	0	4
29-Oct	2B	2	2	0	4
29-Oct	2C	1	0	0	1
29-Oct	2D	1	3	0	4
2-Nov	2B	7	3	0	10
2-Nov	2C	2	1	0	3
2-Nov	2D	2	11	0	13
5-Nov	2B	2	2	0	4
5-Nov	2C	10	17	0	27
5-Nov	2D	7	10	0	17
6-Nov	2D	3	2	0	5
9-Nov	2B	4	3	0	7
9-Nov	2C	14	29	0	43
9-Nov	2D	2	5	0	7
11-Nov	2D	8	15	0	23
12-Nov	2B	5	10	0	15
12-Nov	2C	26	40	0	66
16-Nov	2B	0	1	0	1
16-Nov	2C	1	3	0	4
16-Nov	2D	0	1	0	1
18-Nov	2C	4	3	0	7
19-Nov	2B	1	1	0	2
19-Nov	2C	3	3	0	6
19-Nov	2D	2	0	0	2
23-Nov	2B	1	0	0	1
23-Nov	2D	4	3	0	7
26-Nov	1B	1	0	0	1
26-Nov	2D	1	2	0	3
30-Nov	2B	1	0	0	1
30-Nov	2D	3	3	0	6
Total		119	176	0	295

(a) See Figure 1 for location of recovery areas.

Appendix 5. Sequential mark-recapture data for chinook salmon carcasses in Campbell River, 1998. Carcasses examined on or before the first date of tagging are not included for the mark-recapture estimate (MR).

	Male			Female			Jack			Total		
Date	No. examined	No. tags applied	No. tags recovered	No. examined	No. tags applied	No. tags recovered	No. examined	No. tags applied	No. tags recovered	No. examined	No. tags applied	No. tags recovered
20-Oct	2	2	0	2	2	0	0	0	0	4	4	0
23-Oct	3	3	0	7	4	0	1	0	0	11	7	0
27-Oct	6	5	0	11	9	0	0	0	0	17	14	0
28-Oct	3	3	0	5	4	0	0	0	0	8	7	0
30-Oct	7	7	2	16	11	1	0	0	0	23	18	3
3-Nov	18	14	4	31	25	11	0	0	0	49	39	15
4-Nov	3	3	0	9	8	0	0	0	0	12	11	0
6-Nov	7	2	4	7	4	11	0	0	0	14	6	15
10-Nov	2	2	7	7	5	9	0	0	0	9	7	16
13-Nov	1	0	1	2	2	4	0	0	0	3	2	5
17-Nov	5	3	0	4	4	1	0	0	0	9	7	1
18-Nov	0	0	1	1	0	3	0	0	0	1	0	4
20-Nov	0	0	1	0	0	1	0	0	0	0	0	2
24-Nov	0	0	0	0	0	1	0	0	0	0	0	1
27-Nov	0	0	0	1	0	0	0	0	0	1	0	0
Total	57	44	20	103	78	42	1	0	0	161	122	62
Total for MR(a)	55	42	20	101	76	42	1	0	0	157	118	62

(a) To be used in the Petersen population estimate procedure for the carcass tagging and recovery method. Number of tags examined on the first day of tagging are not included.

Appendix 6. Sequential mark-recapture data for chinook salmon carcasses in Quinsam River, 1998. Carcasses examined on or before the first date of tagging are not included for mark-recapture estimate (MR).

	Male			Female			Jack			Total		
Date	No. examined	No. tags applied	No. tags recovered	No. examined	No. tags applied	No. tags recovered	No. examined	No. tags applied	No. tags recovered	No. examined	No. tags applied	No. tags recovered
9-Oct	1	0	0	0	0	0	0	0	0	1	0	0
14-Oct	0	0	0	1	1	0	0	0	0	1	1	0
15-Oct	1	1	0	0	0	0	0	0	0	1	1	0
21-Oct	3	3	0	3	2	0	0	0	0	6	5	0
22-Oct	3	3	0	9	8	0	0	0	0	12	11	0
26-Oct	17	13	1	14	8	3	2	0	0	33	21	4
29-Oct	36	21	4	26	22	5	3	0	0	65	43	9
2-Nov	91	35	11	78	46	15	9	1	0	178	82	26
5-Nov	89	40	19	95	65	29	8	0	0	192	105	48
6-Nov	3	0	3	7	2	2	1	0	0	11	2	5
9-Nov	127	61	20	139	76	37	5	2	0	271	139	57
11-Nov	11	5	8	25	11	15	3	1	0	39	17	23
12-Nov	63	39	31	40	26	50	4	0	0	107	65	81
16-Nov	16	9	1	9	3	5	0	0	0	25	12	6
18-Nov	9	6	4	5	2	3	0	0	0	14	8	7
19-Nov	15	9	6	8	4	4	0	0	0	23	13	10
23-Nov	9	5	5	5	1	3	0	0	0	14	6	8
26-Nov	3	0	2	1	0	2	0	0	0	4	0	4
30-Nov	6	0	4	4	0	3	0	0	0	10	0	7
Total	503	250	119	469	277	176	35	4	0	1007	531	295
Total for MR(a)	502	250	119	469	277	176	35	4	0	1006	531	295

(a) To be used in the Petersen population estimation procedure for the carcass tagging and recovery method. Numbers of tags examined on the first day of tagging are not included.

Appendix 7. Total dead recovery and adipose clip recovery of chinook salmon in Campbell River, 1998.

	Area 1A (a)								Area 1B (a)								Area 1C (a)							
	Total examined (b)				Adipose clipped recoveries				Total examined (b)				Adipose clipped recoveries				Total examined (b)				Adipose clipped recoveries			
Date	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T
20-Oct	0	0	0	0	0	0	0	0	2	2	0	4	0	0	0	01	0	0	0	0	0	0	0	0
23-Oct	1	0	0	1	0	0	0	0	2	7	1	10	0	1	0	0	0	0	0	0	0	0	0	0
27-Oct	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	9	0	13	0	0	0	0
28-Oct	1	4	0	5	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
30-Oct	0	0	0	0	0	0	0	0	6	15	0	21	0	2	0	4	0	0	0	0	0	0	0	0
03-Nov	5	12	0	17	0	0	0	0	8	15	0	23	1	3	0	0	0	0	0	0	0	0	0	0
04-Nov	0	3	0	3	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
06-Nov	0	3	0	3	0	1	0	1	7	4	0	11	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	0	1	0	1	0	0	0	0	1	4	0	5	0	0	0	1	0	0	0	0	0	0	0	0
13-Nov	0	2	0	2	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
17-Nov	0	0	0	0	0	0	0	0	5	4	0	9	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27-Nov	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Total	8	26	0	34	0	1	0	1	34	52	1	87	2	6	0	8	4	9	0	13	0	0	0	0

(a) See Figure 1 for location of recovery areas

(b) Abbreviations are M = male, F = female, J = jack, T = total

Appendix 8. Total dead recovery and adipose-clip recovery of chinook salmon in Campbell River spawning channel, 1998.

	Channel A (a)								Channel B (a)								Channel C (a)							
	Total examined				Adipose clipped				Total examined				Adipose clipped recoveries				Total examined				Adipose clipped			
Date	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T
27-Oct	0	0	0	0	0	0	0	0	1	2	0	3	0	1	0	1	0	0	0	0	0	0	0	0
28-Oct	0	0	0	0	0	0	0	0	2	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0
30-Oct	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0
03-Nov	5	3	0	8	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
04-Nov	0	0	0	0	0	0	0	0	1	6	0	7	0	0	0	0	0	0	0	0	0	0	0	0
10-Nov	0	0	0	0	0	0	0	0	1	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Total	5	3	0	8	0	0	0	0	6	13	0	19	0	1	0	1	0	0	0	0	0	0	0	0

(a) See Figure 1 for location of recovery areas (The spawning channel was divided into three sections ; channel A is the top 1/3, channel B is the middle 1/3, and channel C is the bottom 1/3 of the channel length)

(b) Abbreviations are M = male, F = female, J = jack, T = total

Appendix 9. Total dead recovery and adipose clip recovery of chinook salmon in Quinsam River, 1998.

	Area 2A (a)								Area 2B (a)							
	Total examined (b)				Adipose clipped recoveries				Total examined (b)				Adipose clipped recoveries			
Date	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T
09-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22-Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26-Oct	0	0	0	0	0	0	0	0	5	6	2	13	0	0	0	0
29-Oct	0	0	0	0	0	0	0	0	11	9	0	20	0	0	0	0
02-Nov	0	0	0	0	0	0	0	0	26	18	2	46	2	2	0	4
05-Nov	0	0	0	0	0	0	0	0	19	11	0	30	1	1	0	2
06-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-Nov	0	0	0	0	0	0	0	0	33	19	1	53	3	1	0	4
11-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-Nov	0	0	0	0	0	0	0	0	21	15	1	37	3	1	0	4
16-Nov	0	0	0	0	0	0	0	0	9	5	0	14	0	5	0	5
18-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19-Nov	0	0	0	0	0	0	0	0	6	4	0	10	0	0	0	0
23-Nov	0	0	0	0	0	0	0	0	2	1	0	3	0	0	0	0
26-Nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-Nov	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0
Total	0	0	0	0	0	0	0	0	133	89	6	228	9	10	0	19

(a) See Figure 1 for location of recovery areas

(b) Abbreviations are M = male, F = female, J = jack, T = total

Appendix 9 (cont'd). Total dead recovery and adipose clip recovery of chinook salmon in Quinsam River, 1998 .

	Area 2C (a)								Area 2D (a)							
	Total examined (b)				Adipose clipped recoveries				Total examined (b)				Adipose clipped recoveries			
Date	M	F	J	T	M	F	J	T	M	F	J	T	M	F	J	T
09-Oct	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1
14-Oct	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
15-Oct	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
21-Oct	0	3	0	3	0	1	0	1	3	0	0	3	0	0	0	0
22-Oct	0	0	0	0	0	0	0	0	3	9	0	12	0	0	0	0
26-Oct	6	1	0	7	1	0	0	1	6	7	0	13	1	1	0	2
29-Oct	15	4	3	22	2	0	1	3	10	13	0	23	0	0	0	0
02-Nov	34	29	3	66	0	3	0	3	31	31	4	66	1	2	0	3
05-Nov	47	47	3	97	3	2	0	5	23	37	5	65	4	4	0	8
06-Nov	0	0	0	0	0	0	0	0	3	7	1	11	0	0	0	0
09-Nov	84	116	4	204	7	7	0	14	10	4	0	14	0	0	0	0
11-Nov	0	0	0	0	0	0	0	0	11	25	3	39	2	1	0	3
12-Nov	40	22	3	65	2	1	0	3	2	3	0	5	0	2	0	2
16-Nov	3	3	0	6	1	1	0	2	4	1	0	5	0	0	0	0
18-Nov	9	5	0	14	0	0	0	0	0	0	0	0	0	0	0	0
19-Nov	8	3	0	11	0	0	0	0	1	1	0	2	0	0	0	0
23-Nov	2	2	0	4	0	0	0	0	5	2	0	7	0	0	0	0
26-Nov	2	0	0	2	0	0	0	0	1	1	0	2	0	0	0	0
30-Nov	3	1	0	4	0	0	0	0	2	2	0	4	0	0	0	0
Total	253	236	16	505	16	15	1	32	117	144	13	274	9	10	0	19

(a) See Figure 1 for location of recovery areas

(b) Abbreviations are M = male, F = female, J = jack, T = total